

ASSESSING SPONTANEOUS COMBUSTION INSTABILITY WITH NONLINEAR TIME SERIES ANALYSIS

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ABSTRACT

Considerable interest lies in the ability to characterize the onset of spontaneous instabilities within liquid propellant rocket engine (LPRE) combustion devices. Linear techniques, such as fast Fourier transforms, various correlation parameters, and critical damping parameters, have been used at great length for over fifty years. Recently, nonlinear time series methods have been applied to deduce information pertaining to instability incipency hidden in seemingly stochastic combustion noise. A technique commonly used in biological sciences known as the Multifractal Detrended Fluctuation Analysis has been extended to the combustion dynamics field, and is introduced here as a data analysis approach complementary to linear ones. Advancing, a modified technique is leveraged to extract artifacts of impending combustion instability that present themselves *a priori* growth to limit cycle amplitudes. Analysis is demonstrated on data from J-2X gas generator testing during which a distinct spontaneous instability was observed. Comparisons are made to previous work wherein the data were characterized using linear approaches. Verification of the technique is performed by examining idealized signals and comparing two separate, independently developed tools.